

WHAT IS CLAIMED IS:

1. A liquid crystal Fabry-Perot etalon comprising:

a first substrate coated on a first side with a first transparent conductor layer;

a first reflector layer disposed over the first transparent conductor layer on the first side of the first substrate;

an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;

a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;

plural spacers disposed between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;

liquid crystal filled in between the first substrate and the spacer plate; and

a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.

2. The liquid crystal Fabry-Perot etalon according to claim 1, wherein the second substrate is spaced a predetermined distance apart from the spacer plate.

3. The liquid crystal Fabry-Perot etalon according to claim 1, wherein the second substrate is disposed directly against the spacer plate.

4. A liquid crystal Fabry-Perot etalon comprising:

a first substrate coated on a first side with a first transparent conductor layer;

a first reflector layer disposed over the first transparent conductor layer on the first side of the first substrate;

an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;

a second transparent conductor layer;

liquid crystal filled in between the alignment layer and the second transparent conductor layer; and

a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the first side of the first substrate;

wherein the first transparent conductor layer and the second transparent conductor layer are each etched so as to form multiple independent etalons.

5. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched according to a grid pattern.

6. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched according to a wedge pattern.

7. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched using a laser.

8. The liquid crystal Fabry-Perot etalon of claim 7, wherein the first and second transparent conductor layers are etched using an Nd:YAG laser.

9. The liquid crystal Fabry-Perot etalon of claim 4, wherein each of the multiple independent etalons is independently tunable to different wavelengths.

10. The liquid crystal Fabry-Perot etalon of claim 4, wherein each of the multiple independent etalons comprises as an independently tunable filter.

11. The liquid crystal Fabry-Perot etalon of claim 4, wherein the second transparent conductor layer is coated on the second substrate.

12. The liquid crystal Fabry-Perot etalon of claim 4, further comprising:  
a spacer plate disposed between the first substrate and the second substrate,  
wherein the second transparent conductor layer is coated on the spacer plate.

13. A liquid crystal Fabry-Perot etalon comprising:  
a first substrate formed of glass;  
a spacer plate formed of glass;  
liquid crystal disposed between the first substrate and the spacer plate;

a second substrate formed of glass, spaced apart from the spacer plate by an air gap;

a phase matched glass-liquid crystal interface reflective coating disposed on a first side of the first substrate, the first side of the first substrate facing the liquid crystal;

a first phase matched glass-air interface anti-reflective coating disposed on a second side of the first substrate opposite its first side;

a phase matched glass- liquid crystal interface anti-reflective coating disposed on a first side of the spacer plate, the first side of the spacer plate facing the liquid crystal;

a second phase matched glass-air interface anti-reflective coating disposed on a second side of the spacer plate opposite its first side;

a phase matched glass-air interface reflective coating disposed on a first side of the second substrate, the first side of the second substrate facing a second side of the spacer plate; and

a third phase matched glass-air interface anti-reflective coating disposed on a second side of the second substrate opposite its first side.

**14.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal reflective coating comprises:

a reflector layer disposed on the first side of the first substrate;

a tin-indium oxide transparent conductor layer disposed over the reflector layer;

and

an alignment layer disposed over the tin-indium oxide transparent conductor layer.

**15.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal anti-reflective coating comprises:

a tin-indium oxide transparent conductor layer disposed on the first side of the spacer plate; and

a alignment layer disposed over the tin-indium oxide transparent conductor layer.

**16.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the etalon has an overall transmission characteristic of about 0.95 or greater.

17. The liquid crystal Fabry-Perot etalon of claim 13, wherein the phase matched glass-to-liquid crystal reflective coating comprises:

- a tin-indium oxide transparent conductor layer;
- multiple alternating layers of  $\text{MgF}_2$  and  $\text{ZrO}_2$ ; and
- a nylon layer.

18. The liquid crystal Fabry-Perot etalon of claim 13, wherein the phase matched glass-to-liquid crystal anti-reflective coating comprises:

- a tin-indium oxide transparent conductor layer;
- multiple alternating layers of  $\text{TiO}_2$  and  $\text{SiO}_2$ ; and
- a nylon layer.

19. An optical wavelength division multiplex device comprising:  
two or more liquid crystal Fabry-Perot etalons connected together in a series combination, wherein each of the liquid crystal Fabry-Perot etalons comprises:

- a first substrate coated on a first side with a first reflector layer;
- a first transparent conductor layer disposed over the first reflector layer on the first side of the first substrate;
- an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;
- a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;
- plural spacers disposed between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;
- liquid crystal filled in between the first substrate and the spacer plate; and
- a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.

20. The optical wavelength division multiplex device according to claim 19, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is spaced a predetermined distance apart from the spacer plate.

**21.** The optical wavelength division multiplex device according to claim 19, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is disposed directly against the spacer plate.

**22.** An optical cross-connect comprising:

a pair of optical wavelength division multiplex devices connected via an optical network, wherein each of the optical wavelength division multiplex devices comprises:

two or more liquid crystal Fabry-Perot etalons in series combination, wherein each of the liquid crystal Fabry-Perot etalons comprises:

a first substrate coated on a first side with a first reflector layer;

a first transparent conductor layer disposed over the first reflector layer on the first side of the first substrate;

an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;

a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;

plural spacers between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;

liquid crystal filled in between the first substrate and the spacer plate; and

a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.

**23.** The optical cross connect according to claim 22, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is spaced a predetermined distance apart from the spacer plate.

**24.** The optical cross connect according to claim 22, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is disposed directly against the spacer plate.

**25.** A liquid crystal Fabry-Perot etalon comprising:

a first substrate formed of glass;

a spacer plate formed of glass;  
liquid crystal disposed between the first substrate and the spacer plate;  
a second substrate formed of glass, spaced apart from the spacer plate by an air gap;

a phase matched glass- liquid crystal interface reflective coating disposed on a first side of the first substrate, the first side of the first substrate facing the liquid crystal, wherein the phase matched glass- liquid crystal interface reflective coating comprises:

a reflector layer disposed on the first side of the first substrate;

a first tin-indium oxide transparent conductor layer disposed over the reflector layer; and

a first alignment layer disposed over the tin-indium oxide transparent conductor layer;

a first phase matched glass-air interface anti-reflective coating disposed on a second side of the first substrate opposite its first side;

a phase matched glass- liquid crystal interface anti-reflective coating disposed on a first side of the spacer plate, the first side of the spacer plate facing the liquid crystal, wherein the phase matched glass- liquid interface crystal anti-reflective coating comprises:

a second tin-indium oxide transparent conductor layer disposed on the first side of the spacer plate; and

a second alignment layer disposed over the tin-indium oxide transparent conductor layer;

a second phase matched glass-air interface anti-reflective coating disposed on a second side of the spacer plate opposite its first side;

a phase matched glass-air interface reflective coating disposed on a first side of the second substrate, the first side of the second substrate facing a second side of the spacer plate; and

a third phase matched glass-air interface anti-reflective coating disposed on a second side of the second substrate opposite its first side;

wherein the first and the second transparent tin-indium oxide conductor layers are each etched in a grid pattern so as to form multiple independent etalons.